THE MEASURE OF DROUGHTINESS

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The Mexican bean beetle is undoubtedly affected by droughty periods, and the question arises how to measure the intensity of a drought. The simplest method is to record the amount of rainfall. This method is unreliable because of the large run-off that often takes place. The southeastern United States, comprising Florida, the southern half of Alabama, Georgia, and South Carolina, with a high ratio of rainfall to evaporation, is nevertheless subject to frequent droughts. The measure of precipitation in this area does not give an adequate idea of the environment. The rainfall comes in torrential storms which dissipate their water in surface run-off. As high as 80 per cent of a 2.5-inch rainfall falling in four hours may be lost by run-off. (Chilcott, 1911.) Columbia, S. C., with 47.55 inches of annual rainfall, may have 62 drought periods in nine years, whereas Ames, Iowa, with only 30.4 inches of rainfall, may have but 23 drought periods. (Williams, 1911.) Thus the degree of temperature and the amount of rainfall required to produce a particular value of relative humidity will differ in the northern United States as contrasted with the southern.

Kincer (1919) maps those areas showing 30 consecutive days or more without 0.25 inch of rainfall in 24 hours. These records point out that the central Appalachian district, including eastern Tennessee, is least subject to droughts, which occur but one year in three. The Plains sections are the most subject to droughts. Munger (1916) suggests that the intensity of a drought is most important and increases in a geometric relation to the length of the dry period. The single variable used is the length of the period without a 24-hour rainfall of 0.05 inch. The following formula is used viz:

Severity of drought = length of drought × ½ length of the drought

Such a formula may approximate the actual conditions of the Pacific slope. East of the Rocky Mountains the summer rainfall is more abundant. The high temperatures that frequently prevail, however, also greatly lower the humidity of the air. The two factors are closely interdependent. In order to incorporate both temperature and rainfall, the following drought index appears to be a measure of the conditions during a droughty period in harmony with the climatic requirements of the bean beetle in the eastern United States.

$$L \times \tfrac{1}{2} L \times \left(\frac{100}{R}\right)^2$$

Where L = the total number of two or more consecutive days above 90° F. for the months of June, July, August, and September, and R = the total summer rainfall for the same months. With this formula, the intensity of a drought is made to increase as the square of its duration, and includes both factors of temperature and precipitation. 100 is used in place of 1 in order to avoid decimals. A drought varies directly as the temperature, and inversly as the precipitation.

Localities with an index of 2,000 or less appear favorable for the bean beetle, while those above 10,000 appear too hot and dry and represent unfavorable conditions. In the following table the drought index numbers have been figured from records for three years, and are not as accurate had a larger number of years been used.

In a more detailed report to be published elsewhere the future distribution of the bean beetle is mapped by the aid of these index numbers.

TABLE 1.—*Climatic index numbers using the formula* $L \times \frac{L}{2} \times \left\{\frac{100}{R}\right\}^2$ *where* L = *the successive number of days above 90° F. and* R = *the summer rainfall*

Locality	$L \times \frac{L}{2}$	Summer rainfall	$\left\{\frac{100}{R}\right\}$	$\left\{\frac{100}{R}\right\}^2$	Index number
Bimingham, Ala	164	16.5	6.0	36.0	5,904
Montgomery, Ala	244	16.0	6.25	39.0	9,516
Centerville, Ala	309	23.0	4.37	19.1	5,871
Yuma, Ariz	3,533	1.1	90.0	8,100.0	2,861,730
Little Rock, Ark	173	15.0	6.66	44.35	7,612
Fort Smith, Ark	160	14.58	6.85	46.92	7,504
San Francisco, Calif	1	.5	200.0	40,000.0	40,000
Denver, Colo	11	6.5	15.38	237.1	2,607
Greeley, Colo	64	5.7	17.54	306.2	19,584
Jacksonville, Fla	96	26.0	3.84	14.74	1,421
Tampa, Fla	292	32.77	3.05	9.3	2,715
Miami, Fla	5	32.56	3.07	94.24	[illegible] 470
Orlando, Fla	632	29.0	3.44	11.83	6,457
Atlanta, Ga	33	16.3	6.13	37.57	1,237
Thomasville, Ga	168	21.9	4.56	20.79	3,494
Springfield, Ill	35	13.4	7.46	55.65	1,946
Vincennes, Ind	205	15.5	6.45	41.60	8,528
Des Moines, Iowa	33	15.5	6.45	41.60	1,372
Lawrence, Kans	96	17.7	5.64	31.80	3,052
Tribune, Kans	132	8.6	11.62	134.5	16,758
Baton Rouge, La	190	23.0	4.34	18.83	3,572
New Orleans, La	211	23.09	4.33	18.74	3,945
Shreveport, La	521	12.76	7.87	61.93	31,749
Mexico City	1	16.7	5.98	35.76	36
Battle Creek, Mich	19	13.4	7.46	55.65	1,056
St. Paul, Minn	10	14.7	6.80	46.24	460
Jackson, Miss	416	15.7	6.37	40.57	16,848
Columbia, Mo	56	13.8	7.24	52.41	2,934
Helena, Mont	4	4.9	20.4	416.1	1,664
Glasgow, Mont	30	5.4	18.5	342.2	10,260
Boston, Mass	6	13.5	7.40	54.76	328
North Platte, Nebr	45	9.92	10.0	100.0	4,500
Bismarck, N. Dak	13	8.9	11.23	125.4	1,625
Agricultural College, N. Mex	862	5.3	18.86	353.4	304,286
Columbus, Ohio	18	12.7	7.87	61.93	1,114
Hamilton, Ohio	106	14.7	6.80	46.24	4,876
Oklahoma City, Okla	500	12.6	7.93	62.88	31,400
Muskogee, Okla	160	13.06	7.7	59.29	9,488
Portland, Oreg	10	4.9	20.40	416.1	4,160
State College, Pa	7	15.0	6.66	44.3	310
Columbia, S. C	88	17.9	5.58	31.13	2,728
Charleston, S. C	34	17.7	5.64	31.80	1,079
Pierre, S. Dak	49	9.2	10.86	116.6	5,684
Crossville, Tenn	1	18.23	5.49	30.14	30
Knoxville, Tenn	28	15.2	6.57	43.16	1,218
Knoxville, Tenn. (1925)	197	7.35	13.6	184.9	36,425
Nashville, Tenn	50	15.01	6.66	44.35	2,217
Jackson, Tenn	223	14.4	6.94	48.16	10,927
Wildersville, Tenn	164	15.0	6.66	44.35	7,265
Trenton, Tenn	326	13.6	7.35	54.02	17,604
Savannah, Tenn	470	13.5	7.40	54.76	25,709
Perryville, Tenn	342	13.5	7.40	54.76	18,810
Austin, Tex	1,512	10.6	9.43	88.92	134,416
Galveston, Tex	32	19.15	5.23	27.35	873
St. George, Utah	953	2,89	34.60	1,197.0	1,140,741
Moab, Utah	500	2.87	34.84	1,211.0	605,500
Roanoke, Va	66	15.3	6.53	42.64	2,811
Diamond Springs, Va	16	23.7	4.22	17.80	284
Fort Laramie, Wyo	71	4.9	20.4	416.1	28,536
Border, Wyo	5	4.7	21.3	453.6	2,268

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